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AND DE-DESERTIFICATION EFFORTS(U) GEOLOGICAL SURVEY
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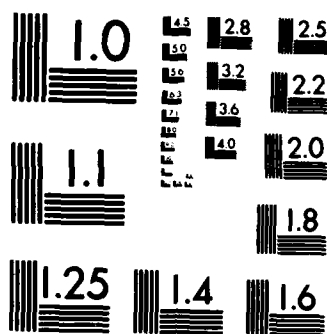
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Figure 1



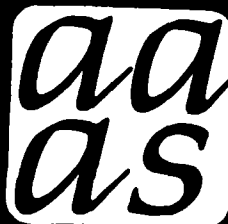
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) -The extremely arid sandy deserts of northwest China lie in intermontane basins or lowlands in the rainshadow of high mountains, which deprive these areas of precipitation and create environments conducive to the development of barren sand dunes and stony (gobi) plains. A legacy of Pleistocene glaciation in these high mountains is a thick cover of sand, silt, and gravel deposited in the lowlands by meltwater streams. The presently much-diminished flow of these streams, and the arid to extremely arid climate of the basins, have allowed		

- desert winds to rework the finer particles from dried-up riverbeds, lakes, and floodplains into loess blankets, sand sheets, and dunes. With the deflation of finer alluvial particles, the coarser gravels and cobbles are left behind, armoring the gobi plains. An end product of the sorting proficiency of desert winds is the concentration of particles in sand sheets and in "sand seas" of dunes that consist of loose, noncohesive mineral and rock grains, mostly quartz. By "eolian depedogenesis", most of the nutritive silt and clay soil particles in these deposits have been winnowed and blown away as dust. Today the surrounding mountains are reservoirs for ice and snow that provide abundant fresh water to irrigate the desert margins during all but the winter months. The unusual geomorphic setting of the Chinese arid lands thus provides a partial remedy for their climatic deficit, and for their desertification problem.



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Delegation Trip Report
**ARID LANDS
IN CHINA**

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TABLE OF CONTENTS

Introduction

Cyrus M. McKell and Lisbeth A. Levey

Desertization Problems in Northern China: An Overview

Henri N. Le Houerou

Geomorphic Aspects of China's Desertification Problem and Dededesertification Efforts

Carol S. Breed

Remote Sensing in Relation to China's Arid Lands

Compton J. Tucker

Sand Fixation and Desert Utilization Technology in Arid Northwestern China

Billie Eugene Dahl

Arid Land Resource Use and New Technologies

Cyrus M. McKell

Water Resource Management in Relation to Desertification and Agricultural Production

Robert M. Hagan

Meeting Challenges of the Future

Members of the Delegation

Literature Cited

Maps

1. Mean Annual Precipitation (mm) for China's Semi-Arid, Arid, and Desert Zones
2. Mean Minimum Temperature: January
3. Mean Maximum Temperature: January
4. Mean Minimum Temperature: July
5. Mean Maximum Temperature: July

Appendices

Lisbeth A. Levey

1. arid lands research in China
2. Itinerary
3. Chinese participants in arid lands symposium
4. papers presented at symposium
5. sites visited and hosts

**GEOMORPHIC ASPECTS OF CHINA'S DESERTIFICATION PROBLEM AND DE-
DESERTIFICATION EFFORTS**

Carol S. Breed

The sandy deserts where we observed "dedesertification" efforts (Zhao, 1984) in northwest China have certain key physical characteristics in common: all are in intermontane basins or lowlands; all have a thick surficial cover of alluvial sand, silt, and gravel, and in some places, monstrous concentrations of sand dunes; all are arid to some degree, but all also receive either seasonal or perennial streamflow from nearby mountains. The Yellow River, which flows past the Tengger sand dunes at Shapotou; the Manas River, which flows to Shihezi from the Tian Shan; and the seasonal flow of meltwater into the Turpan Depression, into the Hexi Corridor, and into the margins of the Taklimakan Desert in the Tarim Basin all supply irrigation water vital to the dedesertification program and provide the source of the hydroelectric energy that helps power it. The high mountains that cast rainshadows over the lowlands of northwest China, depriving them of precipitation and creating environments conducive to the development of sterile sand dunes and stony (gobi) plains, also serve as natural reservoirs for ice and snow, which provide abundant fresh water to the lowlands during all but the winter months. The intermontane setting of the Chinese arid lands thus provides a partial remedy that is not available in most other deserts for their climatic deficiency and their desertification problem.

A legacy of Pleistocene glaciation in the mountains surrounding China's deserts is a thick cover of alluvial sand, silt, and gravel deposited in the lowlands by meltwater

streams. The presently much-diminished flow of these streams, together with the arid to extremely arid climate of the basins, has allowed desert winds to rework the finer particles from dried-up riverbeds, lakes, and flood plains into loess blankets, sand sheets, and dunes. With the deflation of finer alluvial particles, the coarser particles -- gravel and cobbles -- are left behind, armoring the gobi plains. An end product of the sorting proficiency of desert winds is the concentration of sand particles in fields or "sand seas" of dunes, consisting of loose, noncohesive mineral and rock grains, mostly quartz, from which most silt and clay "soil" particles have been winnowed and blown away as dust. The dunes in northwest China are mostly barchanoid and star types, many of which reach heights of 300 meters or more, and occupy thousands of square kilometers in the intermontane basins (Institute of Desert Research, 1977). Active dunes, which generally contain little organic material, support scant or no vegetation in arid regions, except in localities with very shallow groundwater. Moving sometimes as rapidly as 80 m per year, these dunes are a menace to agriculture because they invade croplands, smother fields, and destroy plants with abrasive, wind-blown particles (Liu, 1984). Therefore, much of the reclamation work in China's sandy deserts is twofold:

1. undoing the sorting work of the wind by levelling, irrigating, and fertilizing dune sand, thus "transforming" it into a soil capable of sustaining crops; and
2. controlling the growth and migration of dunes on the periphery of the reclaimed areas.

The best example that we saw of the procedure for controlling migrating dunes ("shifting sands") on the periphery of farm fields is at Shapotou, where 130 m high barchanoid dunes of the Tengger Desert migrate onto terraces of the Yellow River, where they threaten the operation of the railroad line to Lanzhou. By dint of enormous hand labor over a period of twenty-eight years, advancing dunes at Shapotou have been halted by the installation of straw grids or "checkerboards" and repeated plantings of native shrubs. Success of the method is highly dependent on the moisture level within the dunes, which receive an average 200 mm annual rainfall, and which must occasionally be irrigated

and fertilized (Zhu and Liu, 1983).

About 14 hectares of dunes near the research station at Shapotou have been levelled and their sands flooded with silt-laden water pumped from the adjacent Yellow River. Test pits show accumulations of silt that average as much as 1 cm per year, resulting in a loessal soil about 25 cm thick, over (not mixed with) the levelled sand. With irrigation and prodigious applications of goat manure, this man-made soil now supports a variety of crops. This method is reminiscent of the natural fertilization of Egypt's farm fields by annual floods of the silt-laden Nile River before the building of the Aswan High Dam. At Shapotou the method results in a sort of "repedogenesis," i.e., the replacement of the silt and clay particles and organic materials, which the wind winnowed away from the original sediment during the process of dune-building far upwind in the Tengger Desert. Fittingly, these missing soil constituents are replaced from the Yellow River, which owes its color to a vast suspended load of soil particles eroded by wind and running water from the desert plains and plateaus of northern China. The artificial repedogenesis method works well at Shapotou, which has access to a perennial flow of silt-laden water for irrigation. Another factor that may be helpful is the unusual composition of the dune sand at Shapotou. Unlike dune sand in the Western Desert of southwest Egypt, consisting almost entirely of quartz (SiO_2) particles (which are extremely stable and do not break down into soil constituents useful for plant growth), the dune sand at Shapotou contains a high proportion of rock fragments and minerals, such as hornblende and feldspar, which can decompose into clay particles that supply useful soil nutrients.

In the Turpan Depression, "karez" (channels built to collect and tap runoff) and reservoirs are used to obtain surface water for irrigation and reclamation of gobi plains and dune areas. Seasonal runoff in distributaries of the Hotan River, on the southern edge of the Tarim Basin, provides water for planting crops in alluvial silt and for controlling local accumulations of silt dunes. Farther out on the barren gobi plains, at Qira, an oasis is maintained by irrigation within sight of the great dunes of the Taklimakan Sand Sea. These impressive efforts should be of particular interest to the United States

because the oases' soils are derived from the same types of parent materials as those that make up the "breadbasket" soils of the American midwest -- the loessal silts and sands of the High Plains. Like the soils of the desert basins in China, soils of the American plains are a legacy of Pleistocene glaciation, running water, and winds.

A major difference is that the Chinese are attempting to farm such soils under climatic conditions far more arid than many areas in the United States. Through intensive effort, they have successfully reclaimed and are now exploiting the small, select areas of their deserts that are blessed with surface water resources. At present, the Chinese are obtaining the necessary irrigation water from runoff, and have not yet begun to systematically tap the groundwater resources that undoubtedly exist within their desert basins (see Hagan). In contrast, the large-scale cultivation of semi-arid farmlands in the U.S. High Plains requires intensive pumping of groundwater aquifers, such as the Ogallala Formation, for lack of surface water resources. We did not see many of the semi-arid lands of China, which are reportedly in poor condition because of historic misuse of the land and the remobilization of sand dunes previously stabilized by native vegetation (Liu, 1984; Zhu and Liu, 1983). Those areas, which are much more similar in geomorphic setting to the semi-arid American plains than the arid intermontane basins that we visited, are also more comparable in their desertification problems and methods of treatment.

Our visit to the laboratories at the Institute of Desert Research in Lanzhou was unfortunately on a Sunday, the day off for the researchers; thus, only technicians were available to answer questions. Clearly, a great deal of new equipment had been purchased (an SEM, several types of automated instruments for analyzing soil chemistry and textural characteristics, etc.). Without on-site contact with the research scientists, we could not ascertain whether and how the research questions to be investigated with these sophisticated tools are related to specific field problems. We did learn that soils from various localities are being systematically tested in the wind tunnel at Lanzhou to determine their vulnerability to wind erosion under various conditions of soil moisture (from rainfall or irrigation), wind speed, and wind duration. This is a practical and

worthwhile use of the wind tunnel, which is a large (nearly 38 m long), sturdy piece of equipment, with an elegantly constructed, flared intake of polished wood pieces carefully fitted together -- like a "Chinese puzzle." Presumably one purpose of the newer laboratory equipment is to assist basic studies on dune sand provenance, composition, and rates of migration, in order to develop a better understanding of the parent materials that form desert soils and to provide a theoretical basis for developing methods to control shifting sands. One wonders whether the vast literature on this subject has been available to Chinese researchers. In addition, some U.S. researchers now studying desert processes are moving their equipment out of the laboratory and into the field -- using small, portable wind tunnels, and automated geometeorological sensors -- to test theories of eolian sand and dust movement by measuring actual sediment flux under monitored field conditions unique to each desert locality. Chinese researchers might benefit from a careful assessment of their laboratory efforts by U.S. specialists in soil science and wind erosion who have been studying these problems from a pragmatic viewpoint since the Dust Bowl days of the 1930s. On the whole, however, the Chinese researchers are to be complimented for their sustained efforts to study and control wind erosion and deposition. In the United States, such efforts tend to be cyclic, in response to immediate problems, rather than long-term.

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